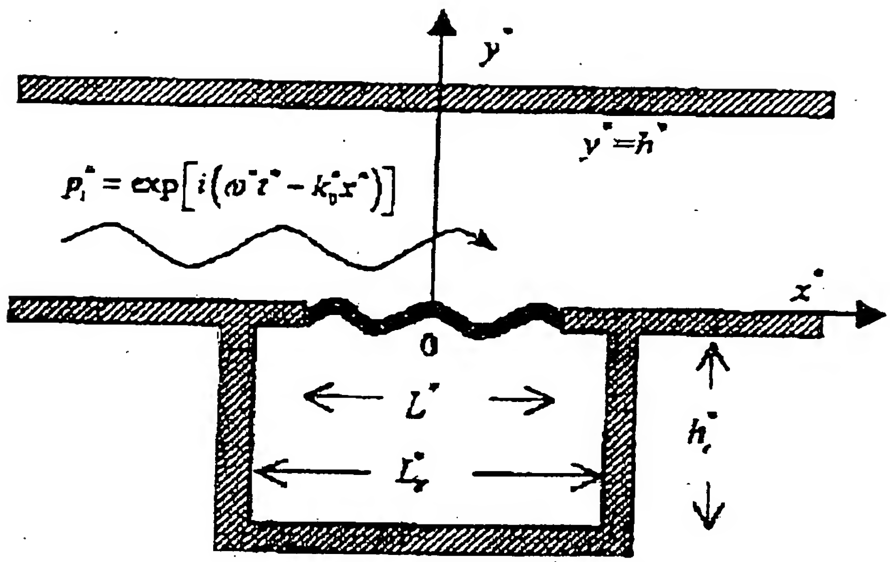


*Figure 1*

Given $h$

Determine $h_c$, $L$ from the practical considerations
Use the minimum $m$ for the membrane

Vary $T$ from 0 to $\rho_0 c_0^2 h^2$

Vary $\omega$, $\omega=2\pi f$, $f$=0 to $c_0/2h$

Find the fluid loading $p_{+rad}$, $p_{-rad}$, $p_{-ref}$ as well as the modal impedance $Z_{jl}$ for a unit vibration velocity which are given below, by Eqs. (13), (14), (16) and (17).

$$p_{+rad}=\frac{L}{2}\sum_{n=0}^{\infty}c_n\psi_n(y)\int_0^1\psi_n(y')V(x')\left[H(x-x')e^{-ik_n(x-x')}+H(x'-x)e^{+ik_n(x-x')}\right]d\xi'.$$

$$p_{-rad}=\frac{L_c}{2}\sum_{n=0}^{\infty}c_{nc}\psi_n(y_c)\int_0^1\psi_n(y_c')[-V(x_c')]\left[H(x_c-x_c')e^{-ik_{nc}(x_c-x_c')}+H(x_c'-x_c)e^{+ik_{nc}(x_c-x_c')}\right]d\xi'.$$

$$p_{-ref}=\frac{L_c}{2}\sum_{n=0}^{\infty}c_{nc}\psi_n(y_c)\int_0^1\psi_n(y_c')[-V(x_c')]\left[\frac{2}{e^{ik_{nc}(2L_c)}-1}\left[\cos k_{nc}(x_c-x_c')+e^{ik_{nc}L_c}\cos k_{nc}(x_c+x_c')\right]\right]d\xi'.$$

$Z_{jl}=\int_0^1 2\sin(l\pi\xi)(p_{+rad}-p_{-rad}-p_{-ref})_j^1 d\xi$, where unit amplitude $V(x')=\sin(j\pi\xi')$.

Solve the dynamics Eq.(22) as part of the Galerkin procedure

$$\begin{bmatrix} Z_{11}+L_1 & Z_{12} & \cdots & Z_{1N} \\ Z_{21} & Z_{22}+L_2 & \cdots & Z_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ Z_{N1} & Z_{N2} & \cdots & Z_{NN}+L_N \end{bmatrix}\begin{bmatrix} V_1 \\ V_2 \\ \vdots \\ V_N \end{bmatrix}=-\begin{bmatrix} I_1 \\ I_2 \\ \vdots \\ I_N \end{bmatrix}.$$

where $L_j=mi\omega+\frac{T}{i\omega}\left(\frac{j\pi}{L}\right)^2$, $I_j=\int_0^1 p_i\sin(j\pi\xi)d\xi$ and $p_i=e^{-ik_0x}$, to obtain $V_j$, $j=1,2,3,\ldots$

Find the reflection wave from $V_j$ according to Eqs. (27) and (28), shown below,

$$p_r=\frac{p_{+rad}|_{n=0,x\to-\infty}}{e^{ik_0x}}=\frac{1}{2}\int_{-L/2}^{+L/2}V(x')e^{-ik_0x'}dx'=\frac{1}{2}\sum_{j=1}^{\infty}V_j\int_{-L/2}^{L/2}\sin(j\pi\xi')e^{-ik_0x'}dx'.$$

and the transmitted wave from Eq. (24),

$$p_t=p_{+rad}|_{n=0,x\to-\infty}+p_i=\frac{1}{2}\int_{-L/2}^{+L/2}V(x')e^{ik_0x'}dx'+1=\frac{1}{2}\sum_{j=1}^{\infty}V_j\int_{-L/2}^{L/2}\sin(j\pi\xi')e^{ik_0x'}dx'+1.$$

Hence the transmission loss from Eq. (25) is calculated as
$TL=-20\log_{10}|p_t|$.

No

If $f>(c_0/2h)$

Yes

Determine $f_1$ and $f_2$ from the transmission loss spectrum so that $TL>TL_{cr}$, in the frequency range of $f\in[f_1,f_2]$,
recommended $TL_{cr}=10\log_{10}\left[1+\frac{1}{4}\left(\left(1+\sqrt{6h_cL}\right)-\left(1+\sqrt{6h_cL}\right)^{-1}\right)^2\right]$.

Find optimal tension $T_{opt}$ for maximum $f_2/f_1$

Optimize $h_c$, $L$ with given cavity volume $h_cL$ if desired

*Figure 2*

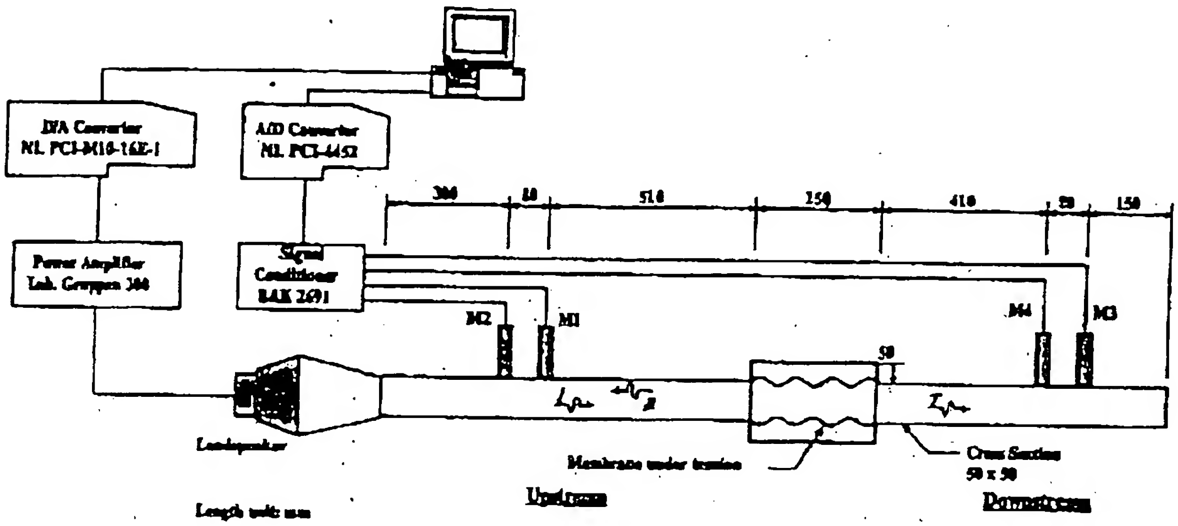


*Figure 3*

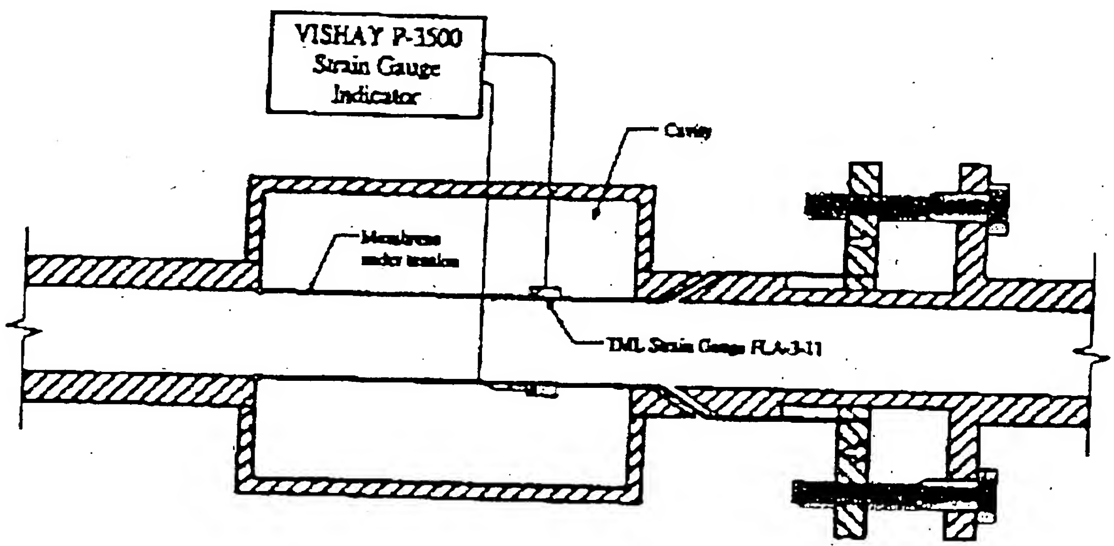


*Figure 4*

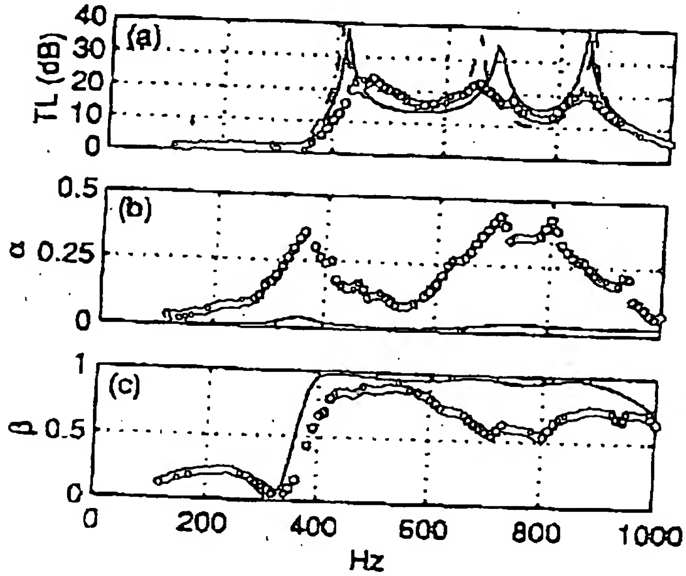


*Figure 5*

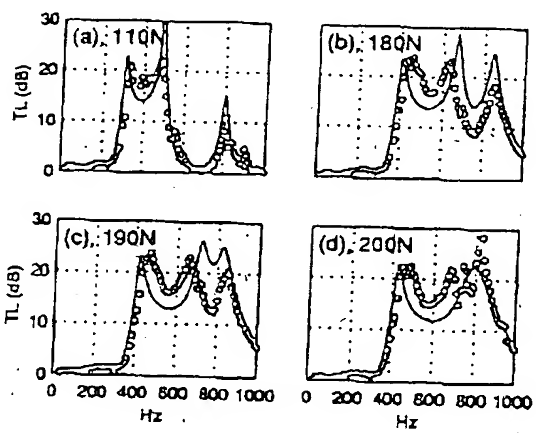


*Figure 6*

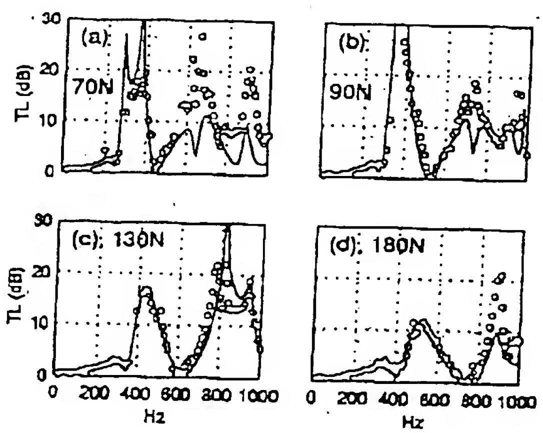


*Figure7*

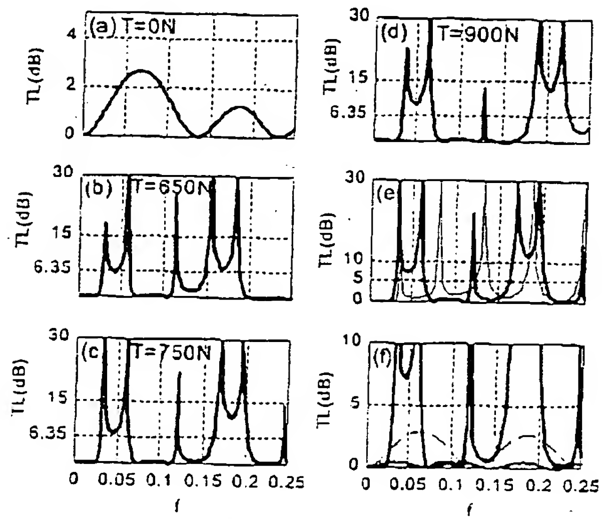


*Figure 8*

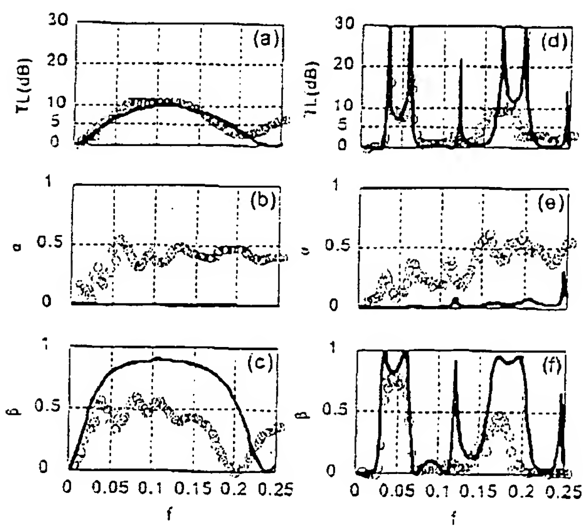


*Figure 9*